



Birzeit University

Faculty of Information Technology
Computer Systems Engineering Department

Digital Lab ENCS 211 EXP. No. 6

Counters, Displays and Drivers

6.1 Objectives:

1. To learn how to use some integrated circuits (ICs) such as counters (IC7490) and 7-segment display driver/decoder (IC7447).
2. To understand the working of the 7-segment display and how to find its pin assignment.
3. To build one, two or more decade counter with display

6.2 Introduction

6.2.1 Seven-Segment Display

The seven-segment LED (Light Emitting Diode) display is a common device in consumer electronics, from calculators to clocks to microwave ovens. In this lab, you will learn the basic principles of operation of the seven-segment display and the process of converting BCD values to the proper signals to drive this display.

The display has seven separate bar-shaped LED's arranged as shown in figure.1. In addition, many seven-segment displays have one (or two) circular LED used as a decimal point.

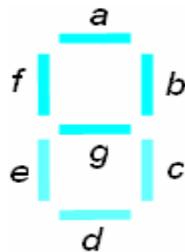


Figure.1: seven-segment display

Inside the seven-segment display, one end of each LED is connected to a common point. This common point is tied either to ground or to the positive supply, depending on the specific device. If your seven-segment display is designed to have the common connection tied to the positive supply, +5V, it is called a **common anode** configuration as shown in figure.2 To light these LED segments, the inputs must be *logic low*.

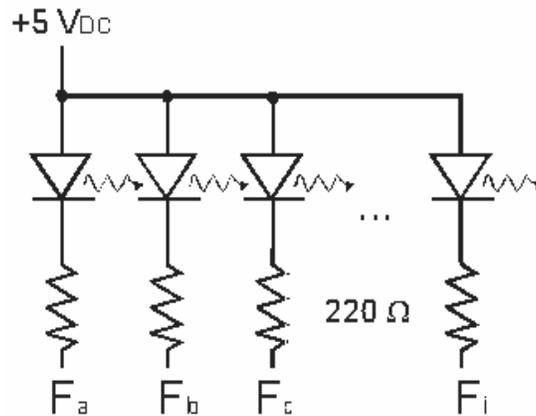


Figure.2: common anode display

If your seven-segment display is designed to have the common connection tied to the ground, 0V, it is called a **common cathode** configuration as shown in figure.3. To light these LED segments, the inputs must be *logic high*.

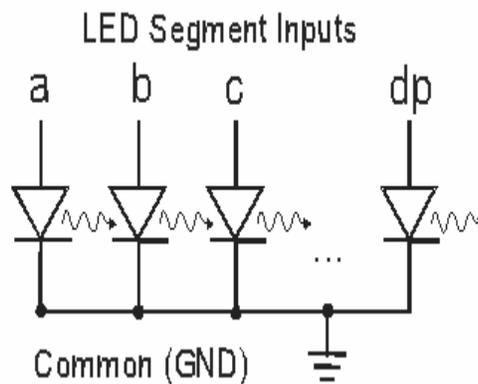


Figure.3: common cathode display

6.2.2 BCD to seven- segment decoder

A seven-segment decoder is a logic circuit often used for the visual display of digital information. The seven outputs of the decoder will drive the seven segments on a corresponding display. The BCD system is used to represent the decimal numbers from 0 to 9 in a binary format suitable for digital devices. A four-bit code is required with the decimal characters 0 through 9 represented by the binary numbers 0000 through 1001. The combinations 1010 through 1111 are not used. A BCD to seven-segment decoder will allow the display of a binary coded decimal on a seven-segment display. The block diagram for this decoder is shown in figure.4, the input to the decoder is a number from 0 through 9 in BCD (0000 though 1001) and the output provides the seven inputs required to drive the seven-segment display.

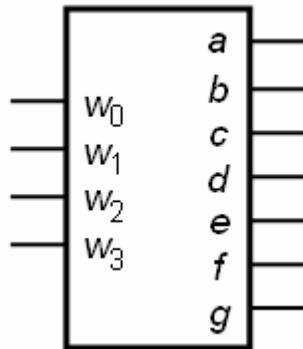


Figure 4: BCD- to seven segment decoder

In this lab the IC type 7447 decoder will be used. The 7447 pin assignment is shown in Figure.5. Its pin description is shown in Table.1

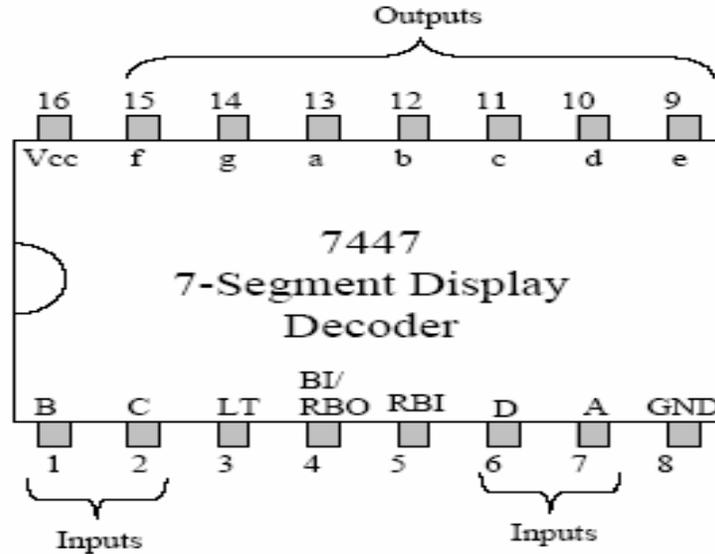


Figure.5: 7447 pin assignment

Pin name	Description
A, B, C, D	BCD inputs; D is the most significant input (DCBA)
a,b,c,d,e,f,g	Decoder output (Active Low)
RBI	Ripple Blanking Input (Active Low)
BI/RBO	Blanking Input (Active Low)/or Ripple Blanking Output (Active Low)
LT	Lamp Test input (Active Low)

Table.1: 7447 pin description

LT is a lamp-test feature, active low. That means this line should be high for normal operation and, when pulled low, all 7-segments will be turned on so you can see all the 'lamps' are still good...

RBI is the ripple blanking input, also active low. It allows you to hide a '0'. When this line is high, and there's a 0 at the inputs, a '0' will be displayed on the display. When the line is low with a 0 at the inputs, nothing will be displayed.

BI/RBO can be used as input and output. BI, active low, used to blank all the segments (turn off the segment)

RBO used with RBI. When RBI activated and the input of DCBA is 0000, RBO will be active to indicate that is blanked. This allows you to hide the leading zero's if, for example' you're displaying a short number on a large display. (For example, 54 instead of 00054)

6.2.3 Counters

In this lab the IC type 7490 counter will be used. The 7490 pin assignment is shown in Figure.6 and its logic diagram is shown in Figure.7

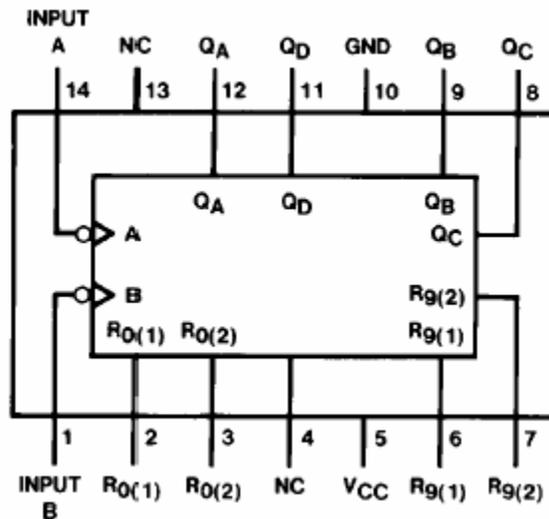


Figure.6: 7490 counter pin assignment

Count	Outputs			
	Q _D	Q _C	Q _B	Q _A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

Table.2: Count sequence of 7490 counter

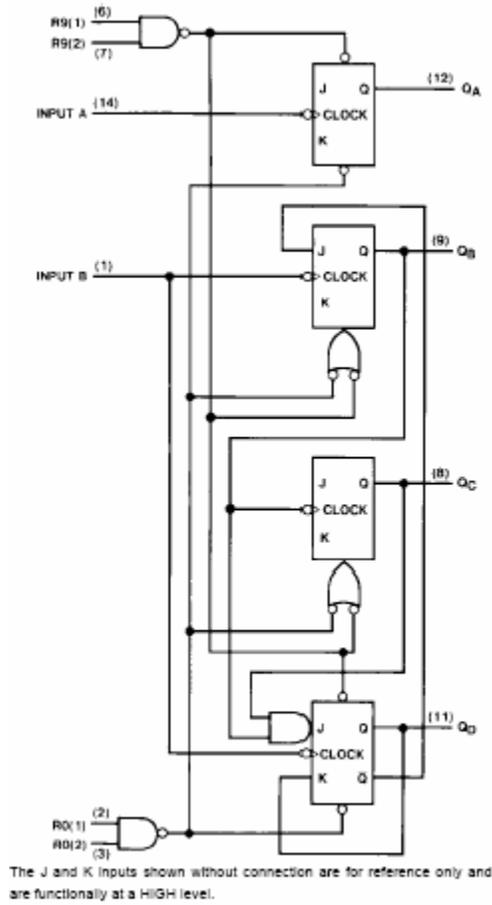


Figure.7: 7490 counter logic diagram

Reset Inputs				Outputs			
R0(1)	R0(2)	R9(1)	R9(2)	Q _D	Q _C	Q _B	Q _A
H	H	L	X	L	L	L	L
H	H	X	L	L	L	L	L
X	X	H	H	H	L	L	H
X	L	X	L	COUNT			
L	X	L	X	COUNT			
L	X	X	L	COUNT			
X	L	L	X	COUNT			

H = HIGH Level
 L = LOW Level
 X = Don't Care

Table.3: Reset/count function table

6.3 Pre Lab:

1. BCD decoder

a. Create the truth table describing the function of a BCD to seven-segment decoder.

The lower case letters, a-g, represent the segments on the display while the upper case letters A-D represent the BCD input. Observe that A is the least-significant bit of the BCD input. Complete Table.4, The seven output of the decoder (a, b, c, d, e, f, g) corresponding the segment display of Figure.1.

#	D	C	B	A	a	b	c	d	e	f	g
0000											
0001											
0010											
0011											
0100											
0101											
0110											
0111											
1000											
1001											

Table.4: Truth table for a BCD to seven-segment decoder

b. After completing the truth table, make K-maps for each of the seven outputs.

Reduce the K-maps to obtain a minimal sum of products expression for each segment.

c. For each K-map, draw the gate level circuits that the equation represents.

Note: Use AND gates and OR gates as required for a two level implementation.

Assume that inputs are available in complimented and un-complimented form.

4. What is the appropriate display type (common anode/common cathode) that must be used with 7447 display decoder? Why?

5. In Figure.8, why pin 12 must be connected to pin 1? What happen if we connect pin 1 to the clock and disconnect pin 12? (See the logic diagram of 7490 counter (Figure))

6.4 Procedure

6.4.1 Seven- Segment display

1. Finding pin assignment:

1. Place the display chip on the breadboard
2. Connect the chip input # ? to the +5V
3. Connect the 0 input to one of the remaining pins of the chip, and find the segment that lights up (is it a, or b, or c...) based on Figure.1.
4. Repeat step 3 for each of the other pins on the chip and find the complete pin assignment for the display

2. Connecting the display with 7447 decoder

a. Test lamps in the display

1. Place the display and the 7447 chips on the breadboard.
2. Implement the circuit shown in Figure.8.
3. Connect pin 4 and pin 5 of the 7447 decoder to the +5V
4. Connect pin 3 (LT) of the 7447 decoder to the ground. All 7 segments must be turned on. This to verify that all segments in the display are work correctly.

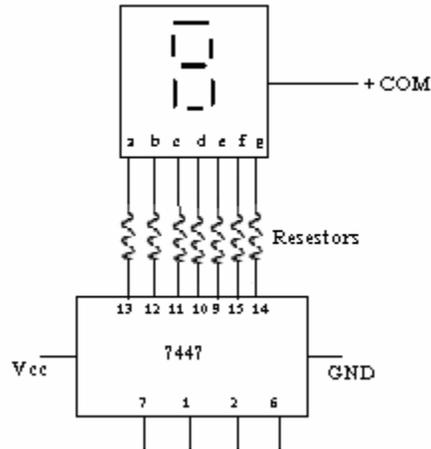


Figure.8: display-decoder connection

b. Blanking all segments

1. Connect pin 4 (BI) of the decoder to the ground. All 7 segments must be turned off.
2. Keep this circuit connected.

6.4.2. 7490 counter circuit:

1. Connect the circuit shown in Figure.9
2. Connect outputs 12, 9, 8, and 11 to the indication lamps L1, L2, L3 and L4 respectively.
3. Apply clock pulses to pin 14 (count) using Pulser switch SWA.
3. Observe the counting sequence, and complete Table.5

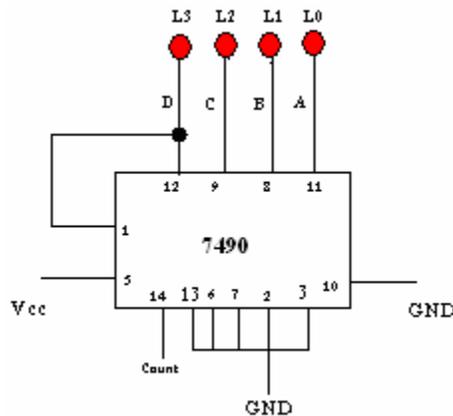


Figure.9: 7490 counter

J	D	C	B	A
∩				
∩				
∩				
∩				
∩				
∩				
∩				
∩				
∩				
∩				

Table.5

6.4.3. Implementing one decade counter

In this part, you will build a counter that counts from 0 to 9

1. Connect the circuit shown in Figure.10
2. Make sure that pins 3, 4 and 5 of IC7447 are connected to the high input.
3. Apply clock pulses to pin 14 (count) using Pulser switch SWA.
4. Observe the counting sequence on the display D1 and complete Table.6
5. Now, apply clock pulses to pin 14 from “pulse generator” of the KL-22001 Basic circuit lab. Observe the count sequence.

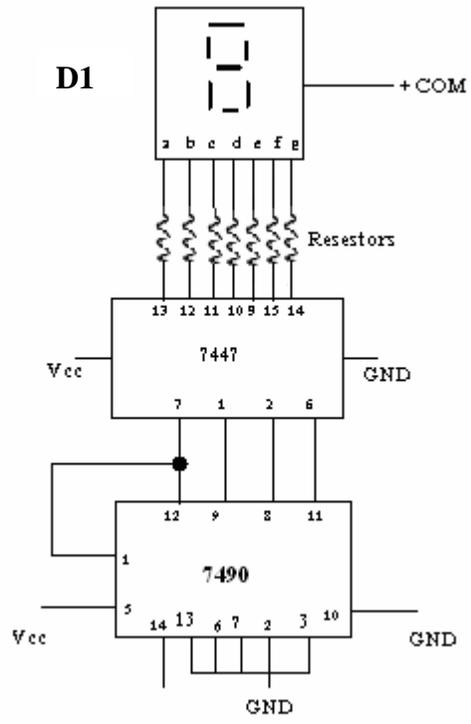


Figure.10: One decade counter

J	D1
High	0
High	1
High	2
High	3
High	4
High	5
High	6
High	7
High	8
High	9
Low	0
Low	1
Low	2
Low	3
Low	4
Low	5
Low	6
Low	7
Low	8
Low	9

Table.6

Task 1:

Design two decades counter that counts from 00 to 99 and implement it. Attach your design schematic with the experiment report.

Task2:

Add additional input to your design that can be used to reset the counter. Attach your design schematic with the experiment report.

Task3:

Modify the counter in Task1 to count to 59 (without Reset). Attach your design schematic with the experiment report.